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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Magneto optical device

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Magneto optical device

The invention relates to a magneto optical device comprising a magneto optical read and/or write head with a coil on a coil holder, and a means for generating a laser beam, wherein in operation the laser beam is shone through the coil.

An embodiment of a system of the type mentioned in the opening paragraph is known from US-A 6,069,853.

In such devices optical recording techniques are combined with a magneto optical head that in operation is brought close to a recording layer on a disk. Polarized laser light is used to read and/or write on the disk. The laser beam is shone through the coil which is e.g. incorporated on a slider or on an actuator. New generations of optical recording disks have ever larger data capacity and smaller bit sizes. There is a tendency that the wavelength for the optical readout decreases and the numerical aperture (NA) of the optical pick up unit (OPU) increases for each new generation. Focal length and working distance decrease, and tilt margins become ever more stringent. For future generations of optical storage systems the numerical aperture of the objective will rise to NA=0.85, or even NA=0.95, to improve resolving power. Despite this tendency of the objective to increase in weight, however, the increasing demand for high data rate and access time forces the total mass of the objective to shrink. With NA kept constant this can only be accomplished if the focal length and hence the free working distance (FWD) is reduced. The head containing the coil is produced using thin film techniques. The coils are made on top of a wafer (e.g. glass) and are embedded in oxide (e.g. Al_2O_3). The free working distance (FWD) between head and disc is less than 20 microns and, as explained above, decreasing for novel designs. It has been found that for such small free working distances a two fold problem occurs: firstly water condenses on the head and secondly, a deposit is left after evaporation of the water. The water and the deposit detrimentally influences the operation of the head, which is especially relevant since the optical requirements of the head and the laser power are ever increasing.

It is an object of the invention to provide a magneto optical device in which the above problem is decreased.

To this end the coil holder comprises a recess with a recess depth at or around the position of the centre of the coil, and a lens extending, seen from the disc, behind the coil and overlapping the coil at least partly.

Water and contamination cannot be deposited on the surface of the head when there is no surface. Water will now be deposited on the surfaces closest to the disc, which are outside the lightpath, without interfering with the light path. It can no longer block or disturb the light path, nor can any contamination be left in the light path after evaporation of the water. A lens is positioned on the coil holder, which lens is positioned behind the coil and also overlaps the coil. This allows the coil to be positioned as close as possible to the disc and thus enabling a relatively large NA while yet allowing a strong magnetic field to be achieved.

Preferably the coil holder comprises a recess extending only at the centre of the coil for reasons of mechanical stability.

The invention also relates to a read and/or write head, as defined in claim 7.

These and other aspects of the invention are apparent from and will be elucidated, by way of example, with reference to the embodiments described hereinafter.

In the drawings:

Figs. 1A and 1B schematically illustrate two designs of heads for magneto optical devices.

Fig. 2 schematically illustrates one of the designs of Fig. 1 in more detail

Fig. 3 schematically illustrates one of the designs of Fig. 1 in more detail

Fig. 4 gives a top view of a coil showing the aperture through which in operation a laser beam is shone

Fig. 5 schematically illustrates in cross-section the light path of a laser beam through the coil

Fig. 6A to 6C illustrate the occurrence of water on the holder.

Figs. 7A to 7D illustrate several designs of a coil holder, wherein figs. 7A and 7D illustrates design outside the scope of the invention, and figures 7B and 7C designs embodying the invention.

Fig. 8 and 9 illustrate various designs of a coil holder within the concept of the invention.

The figures are not drawn to scale. Generally, identical components are denoted by the same reference numerals in the figures.

The present invention is applicable to each and any type of magneto optical device having a read and/or write head and a laser which in operation shines through a coil. Whether the magneto optical device is of the so-called Far Field type and whether or not use is made of a slider or of an actuator.

Figs. 1A and 1B illustrates two types of arrangements. In both arrangements a laser beam 1 is in operation passing an objective lens 2 on a holder 3, through a second lens 4 to be focused on a disk 7. The disk 7 is provided with a cover layer 8. The laser beam 1 is shone through a coil 5. Figure 1A shows a type of read and/or write head of the so-called slider type, in which the second lens 4 and coil 5 is provided on a slider 6. Figure 1B shows a head of the so-called actuator type in which the lens 4 and coil 5 is provided on and/or in a glass wafer 9. The Free Working distance is the distance between the holder 3 and the disk 7.

Fig. 2 shows in more detail a head of the type shown in Fig. 1A. The suspension 10 of the slider is shown in this figure. Figure 3 shows in somewhat more detail a head of the type shown in Fig. 1B.

In all types the head comprises a coil 5. Figure 4 shows in more detail a coil 5. The coil comprises two leads 5a and 5b and an aperture 12 through which the laser beam in operation shines. The coil is part of, applied on, or embedded in the slider 6 or wafer 9.

The head containing the coil is produced using thin film techniques. The coils are made on top of a wafer (e.g. glass) and are embedded in oxide (e.g. Al_2O_3). In Fig 5 a schematic drawing is shown of the head when in use. The free working distance (FWD) between head and disc is less than 20 microns. It has been found that working at these FWD for optical recording poses a problem. The heat generated by the laser spot at the disc causes the evaporation of water inside or on the surface the disc. This water vapour will flow from the disc towards the head. Since the head has a much lower temperature than the disc, the water will condense on the head. This is shown in Figs. 6A, 6B and 6C. The laser light is shone through the centre of the coil (A). In (B) the water is clearly visible. When the laser is turned off, the water will evaporate after some time and some contamination is left (encircled in C).

Figure 7 illustrates several designs. The designs schematically shown in Figs. 7A and 7D do not represent embodiment of coil holder for a device in accordance with the

invention, the designs schematically shown in figures 7B and 7C do represent embodiments of coil holders for a device in accordance with the invention.

In the design shown in Fig. 7A the coil holder does not comprises a recess or hole (hole within the concept of the invention being a specific type of recess) at or near the center of the coil 5.

A number of aspects are of importance for the design:

The diameter of the coil center Dcoil;

The Free Working Distance FWD;

The numerical aperture NA (determined by the angle θ);

The energy efficiency;

The depth of the recess h.

The energy efficiency of the coil decreases as the hole in the coil becomes larger, and also as the distance between the coil and the disk becomes larger. The problem as explained above is the occurrence of water. A reduction of efficiency increase the amount of heat that has to be used, and thus increases the current density and temperature of the coil, which will eventually lead to the breakdown of the coil when the current density or the temperature has passed the critical value. This would force the use of coil with more or larger windings, thus increasing the inductance and capacitance of the coil dramatically, which in turn will decrease the resonance frequency (and thus the bandwidth) of the coil.

Figure 7A illustrates a standard design. In figure 7A the coil comprises a coil center. As explained the heat generated by the coil causes water to evaporate with the mentioned problems. In figure 7B a recess is made in the coil. This slightly increases the coil centre diameter (thus d1 is larger than Dcoil0). However, the positive effect of a reduction of water condensation on the centre outweighs the decrease in power efficiency. Figure 7C illustrates a further embodiment of the invention. Comparing the design of figure 7C to that of figure 7B it is apparent that whereas in figure 7B a recess is made in the centre of the coil, in figure 7C the coil itself is recessed in respect of the rest of the holder. This means that the coil centre diameter is slightly larger and that the distance between the coil and the disk is increased from FWD to FWD+h. The latter also leads to a decrease of the power efficiency, since the distance between the coil and the disk increases. However, depending on the distance h and the coil diameter advantages outweighing the disadvantages may still be obtained. Preferably the recess depth h is less than 2 FWD, preferably less than FWD, but preferably more than ½ FWD. The design as schematically shown in figure 7B is preferred over the design shown in figure 7C, since for reasons of power efficiency. However, also for

the designs of figure 7B the recess depth h is preferably within the ranges (as compared to FWD) as indicated above.

Finally in the design shown in figure 7D the coil 5 is placed around an aperture in which the lens 4 is positioned, in this design however, although the center of the coil is recessed, the power efficiency is so much decreased that the advantages do no longer outweigh the disadvantages. The lens and coil are so positioned that they do no longer overlap. With overlapping is meant that, seen from the disk, the lens at least partly extends behind the coil winding(s), i.e. the diameter of the lens is larger than the diameter of the aperture in the coil. In the design in figure 7D the diameter of the lens is less than the diameter of the centre of the coil the center, the lens fits inside the aperture in the coil. As a consequence, compared to the designs of figure 7B and 7C the diameter of the aperture in the coil is increased, the coil is larger and a considerable reduction in efficiency occurs, with the above mentioned disadvantages. The use of the word "diameter" is to be seen in a non-restrictive manner, as indicating a dimension or size, not necessarily restricting the elements (lens, aperture, coil) to which the word applies to purely circular or cylindrical objects.

Figures 8A, 8B and 9 illustrates schematically various embodiments of a coil holder for a device in accordance with the invention.

In Figures 8A and 8B a hole is made in the optical center of the coil. Water and contamination cannot be deposited on the surface of the head when there is none: Water will now be deposited on the surface closest to the disc, either on the sidewalls or on top of the coils, next to the hole. It can no longer block or disturb the lightpath. The depth of the coil depends on the inner diameter of the coil. In figure 8A a slightly more complex lens system is used comprising a lens 4 and a lens 4A. The coil is e.g. made of Cu, covered by Al_2O_3. A hole can be etched in oxide by either wet or dry etching. The thickness of the coil layer is e.g. 4 micron, 2 micron of oxide between the layers 5C and 5D and 0.5-micron oxide on layer 5C.

Figure 9 shows yet a further embodiment. The substrate supporting the coil has now also a hole. This can be manufactured in two ways:

1. The coil is manufactured on a substrate and after processing the front side, a hole is processed in the back side of the substrate. This hole can be made using a combination of a "rough" technique (e.g. powder blasting) and wet or dry etching. Since the laser light only travels through air, also opaque substrates can be used, especially Si. This would have the advantage that the coil can be made directly on an IC.

2. The coil is manufactured using Silicon on Anything (as proposed in international patent application WO200213188). After the fabrication of the coil with a hole, the whole can be put on a carrier.

This embodiment has the advantage that a carrier can be chosen which has better thermal conductance λ (W/m^2K) than the often used glass. Glass has typical value for λ of 1, while SiO2 is 4 to 8, Al_2O_3 is around 25 and SiC is 125. The better the thermal conductance, the better the coil will be cooled, and thus the higher the current that can be used compared to a normal coil. This would more than counteract the negative effect of the larger coil diameter that is necessary for a coil with a hole compared to normal coil.

Summarizing the invention can be described as follows:

In a magneto optical device is which a laser beam is shone in operation through a coil, the coil holder comprises a recess at or around the position of the optical centre of the coil, and a lens extending, seen from the disc, behind the coil and overlapping the coil at least partly.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. The invention resides in each and every novel characteristic feature and each and every combination of characteristic features. Reference numerals in the claims do not limit their protective scope. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements other than those stated in the claims. Use of the article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

CLAIMS:

1. Magneto optical device comprising a magneto optical read and/or a write head with a coil holder (6, 9) comprising a coil (5), and a means for generating a laser beam (1) wherein in operation the laser beam is shone through an aperture (12) in the coil (5), which coil holder comprises a recess with a recess depth (h) at or around the position of the centre of the coil, wherein a lens (4) extends, seen from the disc, behind the coil and overlaps the coil at least partly.

2. Magneto optical device as claimed in claim 1, characterized in that the recess is restricted to an area within the aperture in the coil.

3. Magneto optical device as claimed in claim 1, characterized in that the coil (5) is positioned in the recess.

4. Magneto optical device as claimed in claim 1, characterized in that the depth of the recess (h) is less than twice the free working distance (FWD).

5. Magneto optical device as claimed in claim 4, characterized in that the depth of the recess is less than the free working distance.

6. Magneto optical device as claimed in claim 4 or 5, characterized in that the depth of the recess (h) is more than ½ of the free working distance.

7. Read and/or write head presenting all the features of the head disclosed in any one of the preceding claims and being thus constructed and evidently intended for use in the magneto optical device as claimed in any one of the preceding claims.

ABSTRACT:

Magneto optical device comprising a magneto optical read and/or write head with a coil (5), and a means for generating a laser beam (1), wherein in operation the laser beam is shone through an aperture (12) in the coil (5), characterized in that the coil holder comprises a recess at or around the position of the optical centre of the coil, and a lens (4) ~~extending, seen from the disc, behind the coil and overlapping the coil at least partly.~~

Figure 7B

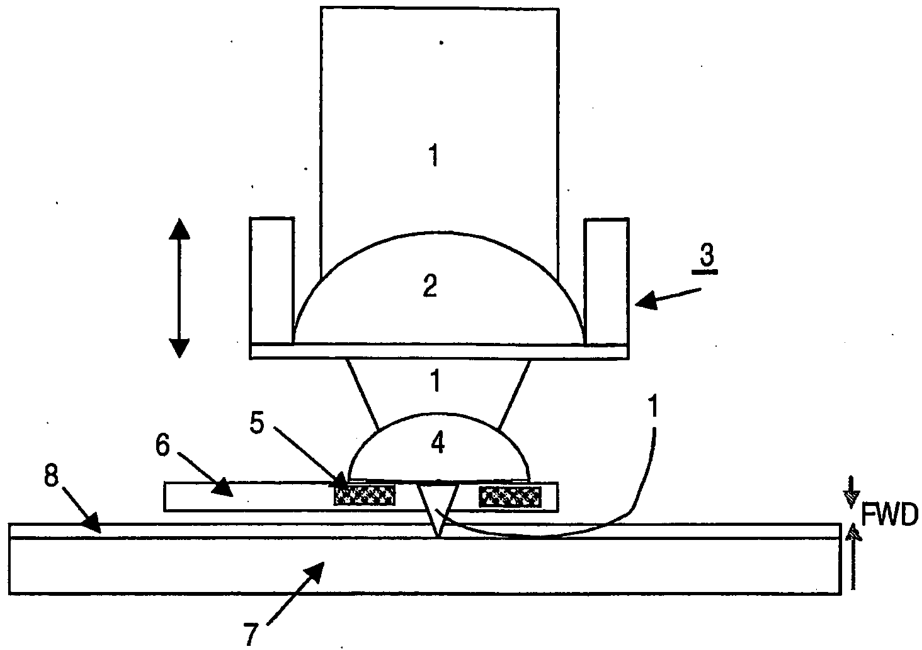

FIG.1A

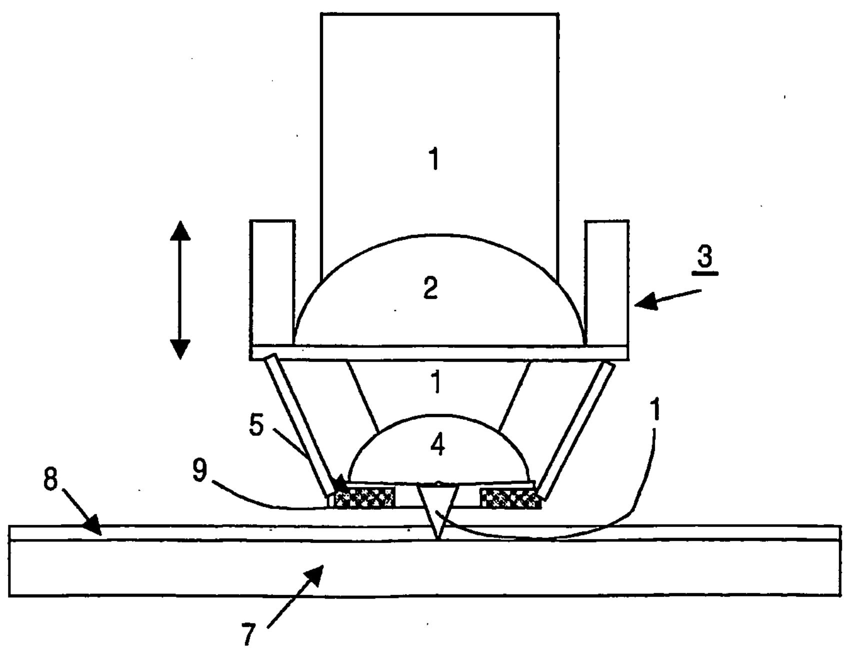

FIG.1B

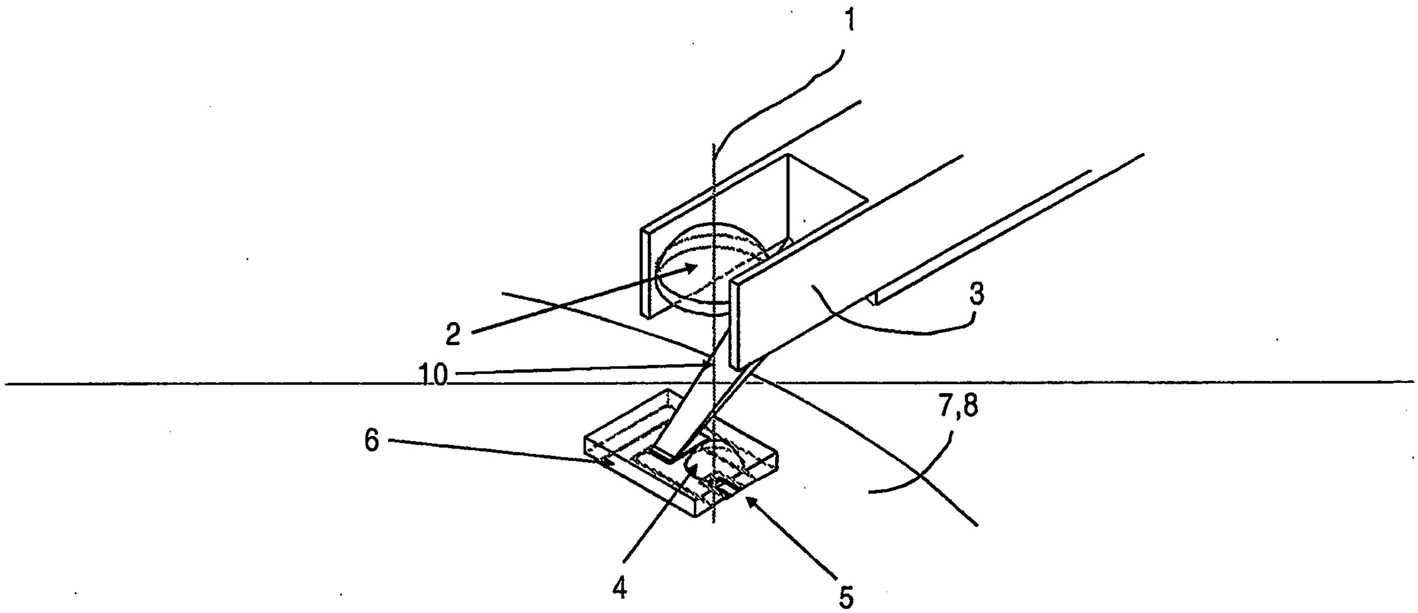

FIG.2

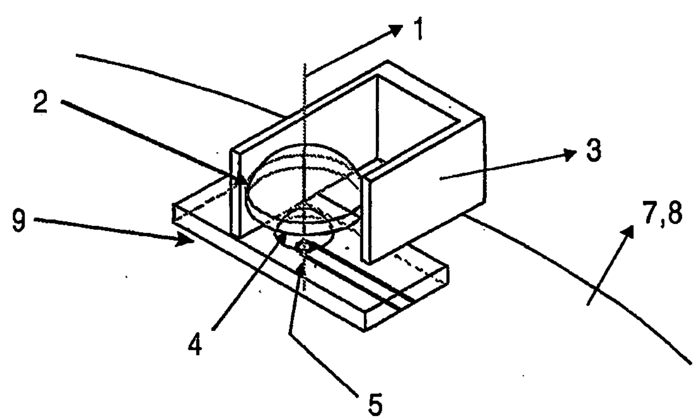

FIG.3

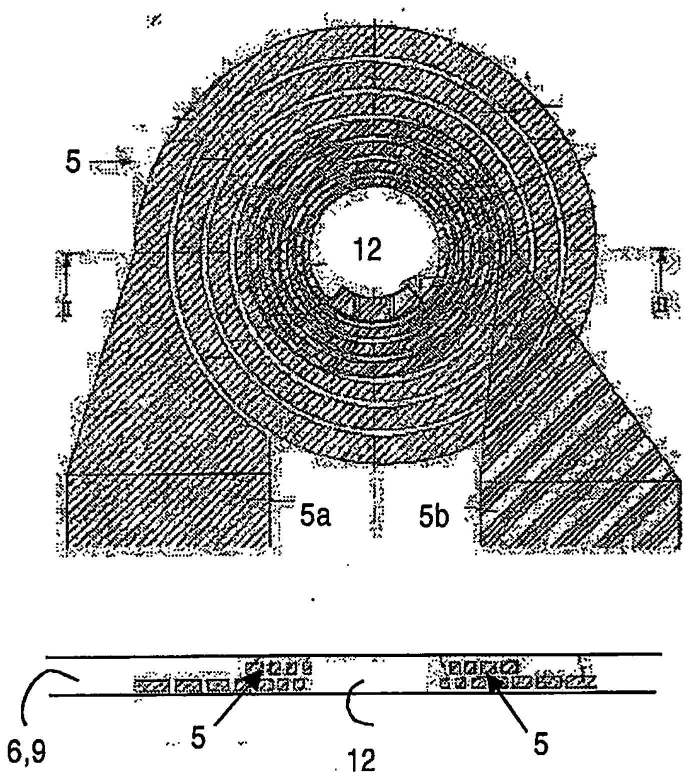

FIG.4

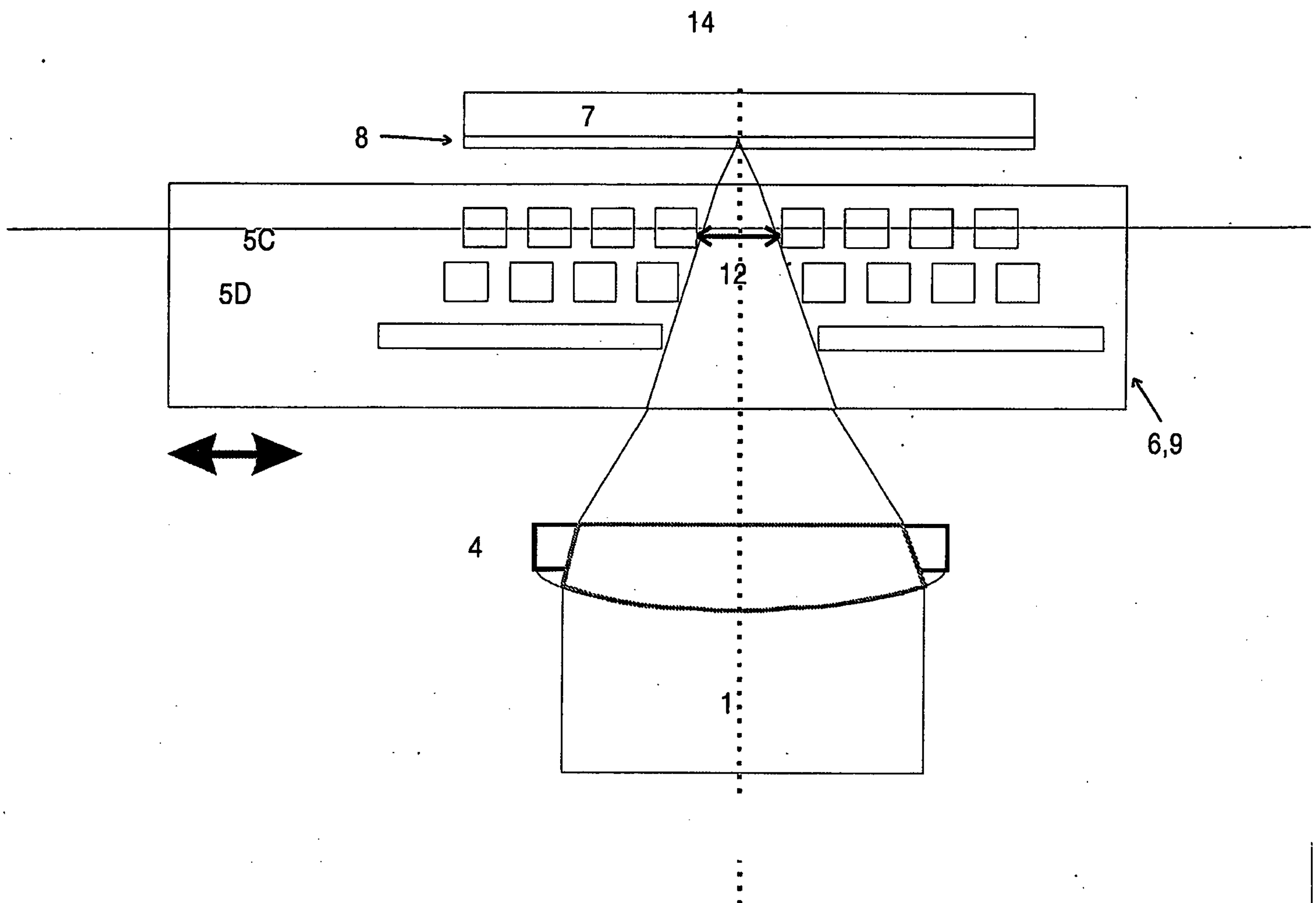

FIG.5

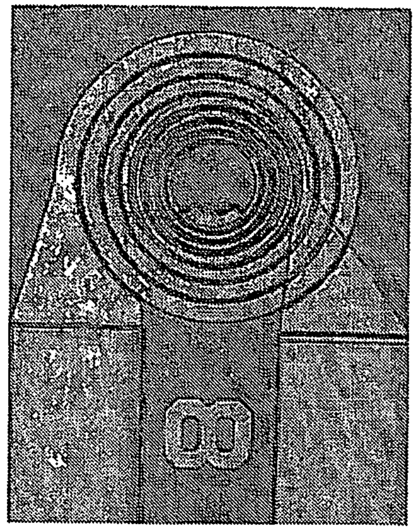

FIG.6A

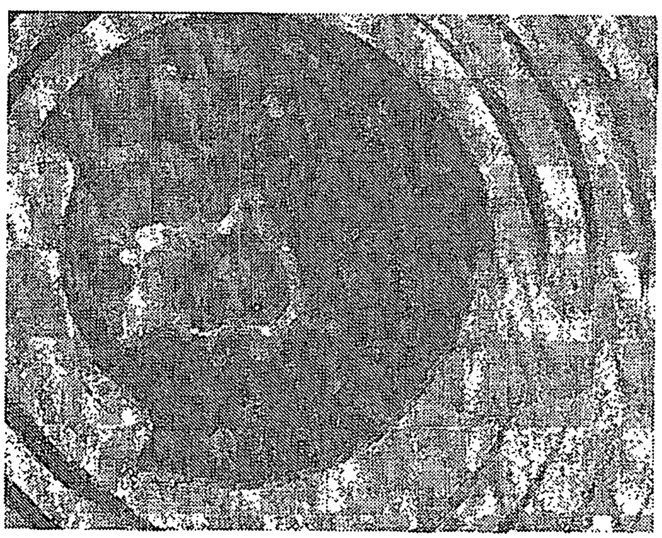

FIG.6B

FIG.6C

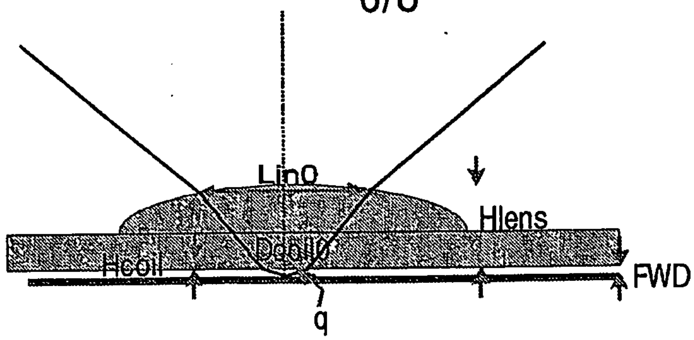

FIG.7A

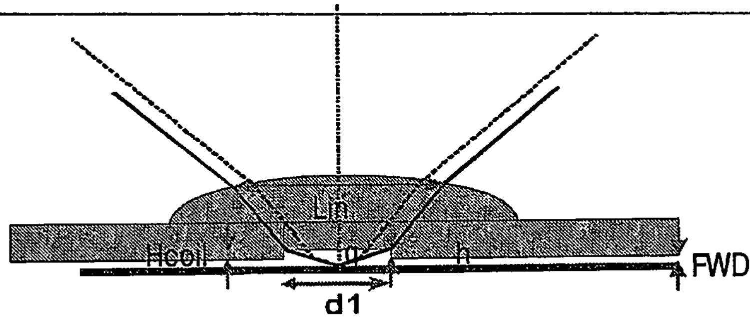

FIG.7B

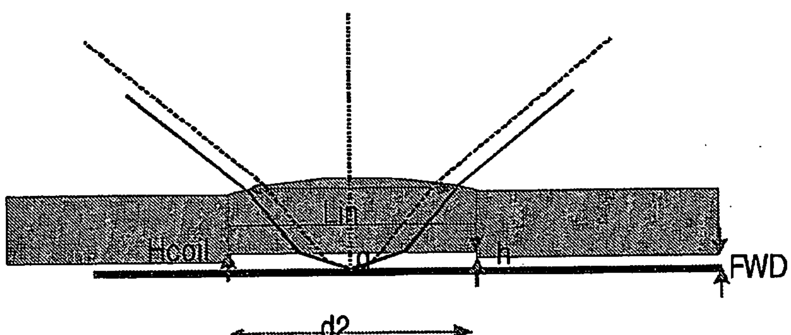

FIG.7C

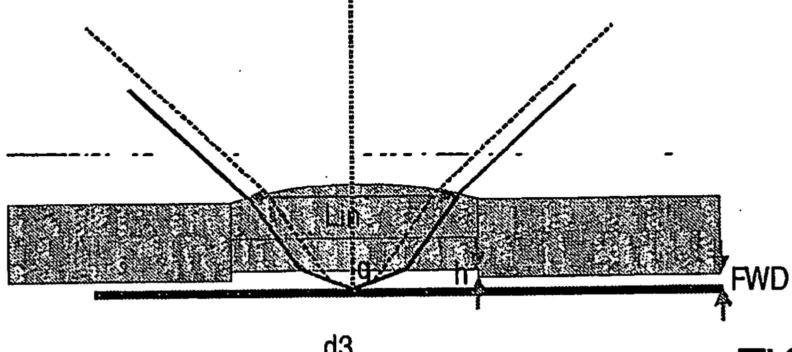

FIG.7D

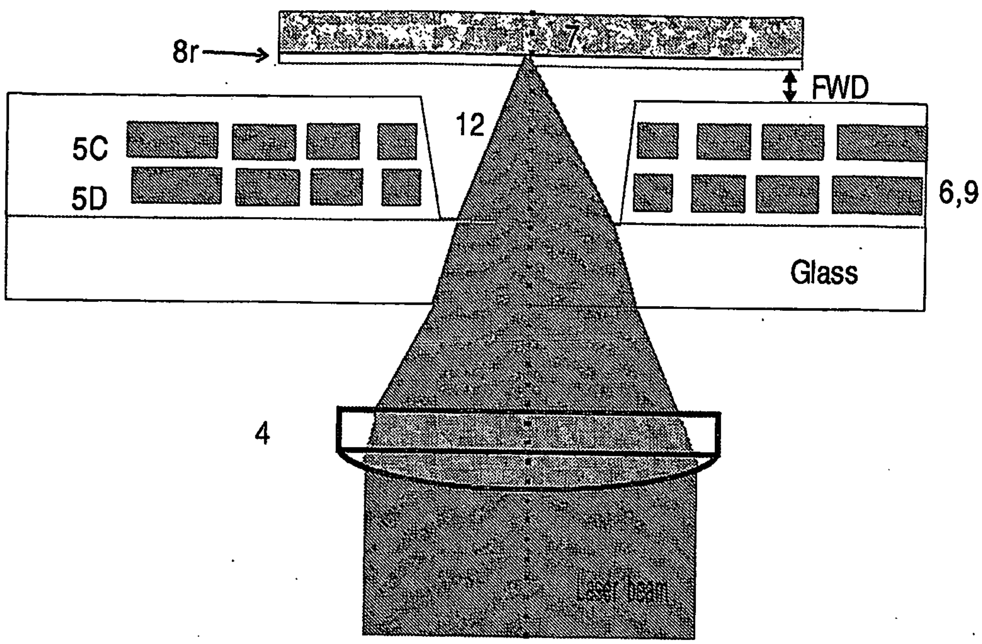
7
8r
FWD
12
5C
5D
6,9
Glass
4
Laser beam

FIG.8A

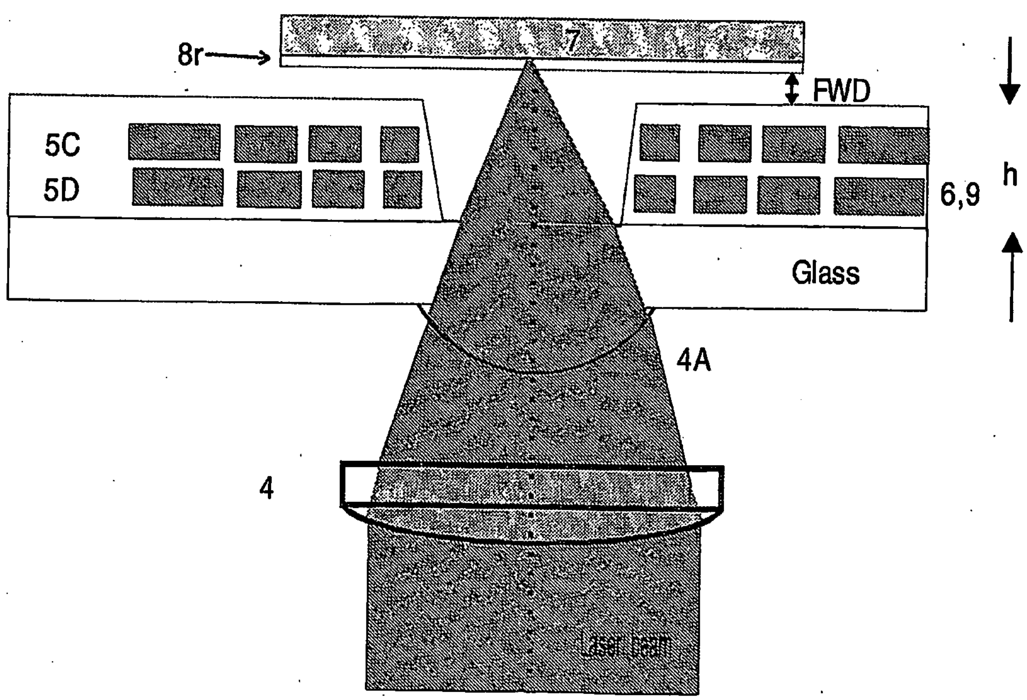
7
8r
FWD
5C
5D
6,9
h
Glass
4A
4
Laser beam

FIG.8B

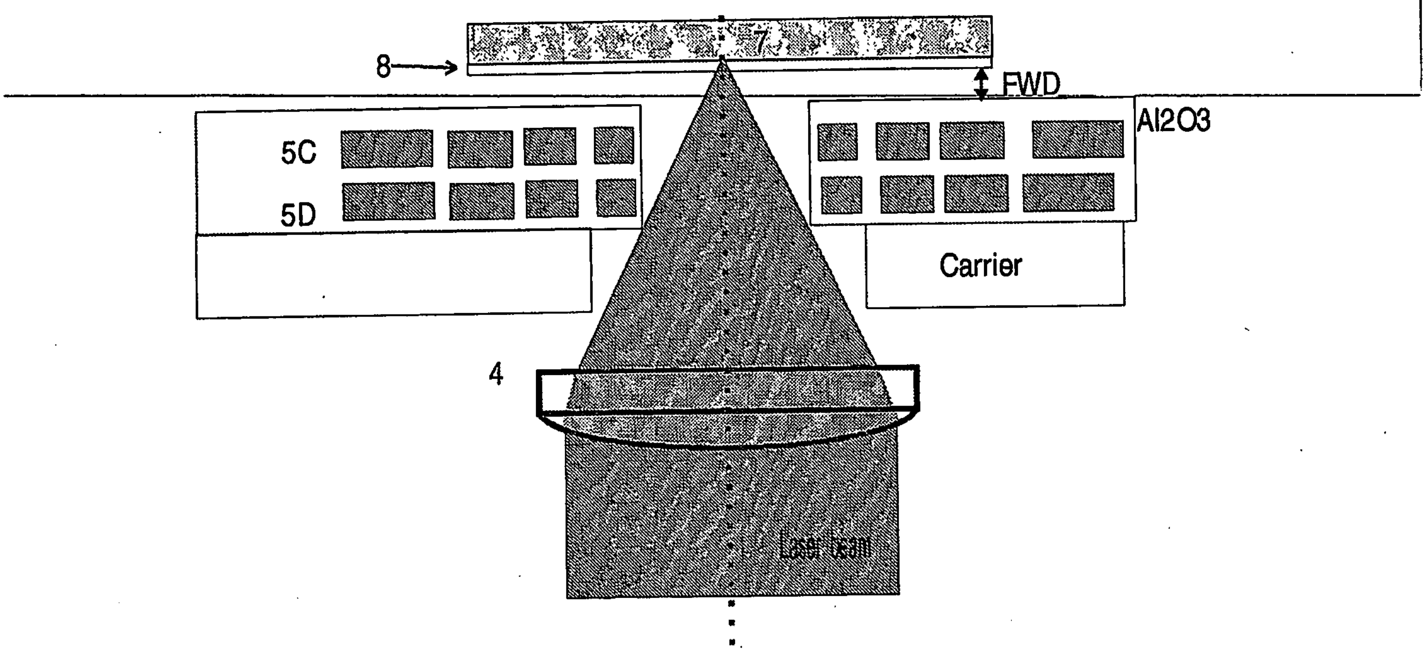

FIG.9